Professor Röntgen, of Würzburg, profiting by Lenard's results, accidentally discovered that the rays coming from a Crookes tube, through the glass itself, could photograph the bones in the living hand, coins inside a purse, and other objects covered up or hid in the dark. Some bodies, such as flesh, paper, wood, ebonite, or vulcanised fibre, thin sheets of metal, and so on, are more or less transparent, and others, such as bones, carbon, quartz, thick plates of metal, are more or less opaque to the rays. The human hand, for example, consisting of flesh and bones, allows the rays to pass easily through the flesh, but not through the bones. Consequently, when it is interposed between the rays and a photographic plate, the skeleton inside is photographed on the plate. A lead pencil photographed in this way shows only the black lead, and a razor with a horn handle only the blade.

Thanks to the courtesy of Mr A. A. Campbell Swinton, of the firm of Swinton & Stanton, the well-known electrical engineers, of Victoria Street, Westminster, a skilful experimentalist, who was the first to turn to the subject in this country, I have witnessed the taking of these "shadow photographs," as they are called, somewhat erroneously, for "radiographs" or "cryptographs" would be a better word, and shall briefly describe his method. Röntgen employs an induction coil insulated in oil to excite the Crookes tube and yield the rays, but Mr Swinton uses a "high frequency current," obtained from apparatus similar

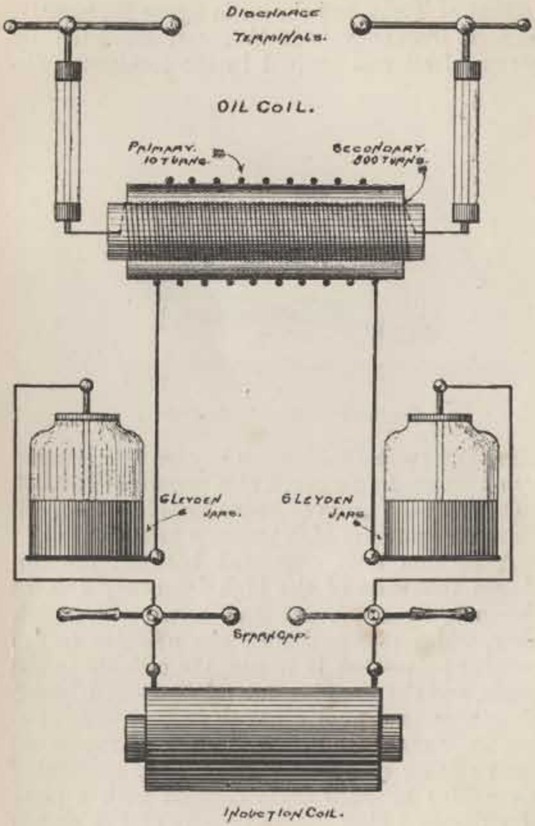


FIG. 98.—Photographing the Unseen.

to that of Tesla, and shown in figure 98, namely, a high frequency induction coil insulated by means of oil and excited by the continuous dis-

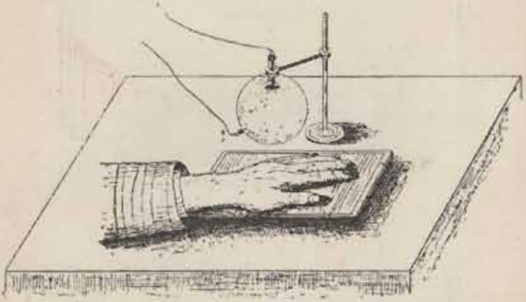

FIG. 99.—Photographing the Skeleton.

charge of twelve half-gallon Leyden jars charged by an alternating current at a pressure of 20,000 volts produced by an ordinary large induction coil sparking across its high pressure terminals.

A vacuum bulb connected between the discharge terminals of the high frequency coil, as shown in figure 99, was illuminated with a pink glow, which streamed from the negative to the positive pole—that is to say, the cathode to the anode, and the glass became luminous with bluish phosphorescence and greenish fluorescence. Immediately under the bulb was placed my naked hand resting on a photographic slide containing a sensitive bromide plate covered with a plate of vulcanised fibre. An exposure of five or ten minutes is sufficient to give a good picture of the bones, as will be seen from the frontispiece.

The term "shadow" photograph requires a word of explanation. The bones do not appear as flat shadows, but rounded like solid bodies, as though the active rays passed through their substance. According to Röntgen, these "x" rays, as he calls them, are not true cathode rays, partly because they are not deflected by a magnet, but cathode rays transformed by the glass of the tube; and they are probably not ultra-violet rays, because they are not refracted by water or reflected from surfaces. He thinks they are the missing "longitudinal" rays of light whose existence has been conjectured by Lord Kelvin and others—that is to say, waves in which the ether sways to and fro along the direction of the ray, as in the case of sound vibrations, and not from side to side across it as in ordinary light.

Be this as it may, his discovery has opened up a new field of research and invention. It has been found that the immediate source of the rays is the fluorescence and phosphorescence of the glass, and they are more effective when the fluorescence is greenish-yellow or canary colour. Certain salts—for example, the sulphates of zinc and of calcium, barium platino-cyanide, tungstate of calcium, and the double sulphate of uranyle and potassium—are more active than glass, and even emit the rays after exposure to ordinary light, if not also in the dark. Salvioni of Perugia has invented a "cryptoscope," which enables us to see the hidden object without the aid of photography by allowing the rays to fall on a plate coated with one of these phosphorescent substances. Already the new method has been

applied by doctors in examining malformations and diseases of the bones or internal organs, and in localising and extracting bullets, needles, or other foreign matters in the body. There is little doubt that it will be very useful as an adjunct to hospitals, especially in warfare, and, if the apparatus can be reduced in size, it will be employed by ordinary practitioners. It has also been used to photograph the skeleton of a mummy, and to detect true from artificial gems. However, one cannot now easily predict its future value, and applications will be found out one after another as time goes on.